

APPLICATION FOR UNITED STATES PATENT

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INVENTION: Improved Polyurethane Coating Process For
Carpet Backing

SPECIFICATION

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1 **IMPROVED POLYURETHANE COATING PROCESS FOR CARPET BACKING**

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3 **RELATED APPLICATION DATA**
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5 The present application is a continuation-in-part
6 of PCT/US02/35391 filed November 5, 2002, which is a
7 continuation-in-part of U.S. Serial No. 09/993,864, pending,
8 which in turn claims priority from U.S. Provisional Application
9 Ser. No. 60/245,966 entitled POLYURETHANE COATING PROCESS FOR
10 CARPET filed on November 3, 2000, the entire specification of
11 each being incorporated herein by reference.

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14 **FIELD OF THE INVENTION**
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16 **[0001]** The present invention relates to improved methods
17 for adhering secondary backing to tufted or woven carpeting
18 employing polyurethane adhesive systems.

19
20 **BACKGROUND OF THE INVENTION**

21 **[0002]** Polyurethanes are produced in four different
22 principal forms including elastomers, coatings, flexible foams,
23 and cross-linked foams. Polyurethane foams are produced by
24 reacting isocyanate compounds with polyol compounds generally in
25 the presence of catalysts, surfactants, and other auxiliary
26 agents. At the start of polyurethane foam production, the

1 reactive raw materials are held as liquids in large, stainless
2 steel tanks. These tanks are equipped with agitators to keep
3 the materials fluid. A metering device is attached to the tanks
4 so that the appropriate amount of the reactive material can be
5 pumped out. Generally, the ratio of polyol to isocyanate is
6 about 1:2; and the ratio of components is strictly metered to
7 control the characteristics of the resulting polymers. The
8 reacting materials are then mixed and dispensed. Reaction
9 between the isocyanate and the polyol, usually referred to as
10 the gel reaction, leads to the formation of a polymer of high
11 molecular weight. This reaction increases the viscosity of the
12 mixture and generally contributes to cross-link formation. The
13 second major reaction occurs between isocyanate and water. This
14 reactive produces carbon dioxide gas which promotes foaming
15 causing the volume of the urethane polymer to grow. In some
16 instances, auxiliary blowing agents are added to further
17 increase the volume of the polymer.

18 [0003] Both the gel and blow reactions occur in foams
19 blown partially or totally with carbon dioxide gas. In order to
20 obtain a good urethane foam structure, the gel and blow
21 reactions must proceed simultaneously and at optimum balance
22 rates. For example, if the carbon dioxide generation is too
23 rapid in comparison with the gel reaction, the foam tends to

1 collapse. Alternatively, if the gel reaction is too rapid in
2 comparison with the blow reaction generating carbon dioxide, the
3 rise of the foam will be restricted resulting in high density
4 form. In practice, the balancing of these two reactions is
5 controlled by the natures of catalysts and auxiliary agents used
6 in the process.

7 [0004] It is customary in the carpet and rug industry to
8 use various forms of filled and unfilled latex or polyurethane
9 to coat the back of carpet. The coating is used to bond the
10 face fibers to the primary backing and also thereby creating
11 good tuft bind or fiber lock, to bond secondary backing material
12 to the greige (fibers/primary backing). For example, carpets
13 having attached polyurethane layers as backing are described in
14 U.S. Pat. Nos. 3,755,212; 3,821,130; 3,862,879; 4,022,941;
15 4,515,646; 5,604,267; 5,908,701; and 6,299,715. A key property
16 of the carpet produced by these methods is annealing strength,
17 the force required to separate the secondary backing from the
18 carpet. In order to achieve optimal annealing strength, the
19 secondary backing must be in direct contact with the greige, and
20 a sufficient amount of adhesive must be between the greige and
21 the secondary backing to thoroughly wet the fibers. Another key
22 property is, the fiber lock, which measures the force necessary
23 to pull face fibers from the carpet.

1 **[0005]** The most widely used annealing adhesive is latex.
2 Latex is typically applied by methods involving roll over
3 flatbed or roll over roll processes. Regardless, of the method
4 used, the greige is coated with an adhesive precoat of latex,
5 and the secondary backing, also coated with latex, is married to
6 the greige and cured.

7 **[0006]** Although, latex is a popular adhesive, carpet
8 prepared from latex displays numerous shortcomings. For
9 example, the strength and hydrolytic stability of latex is less
10 than desired, and latex is less durable over time than
11 alternative polymer systems such as PVC plastisol or
12 polyurethane. Moreover, latex curing requires the evaporation
13 of large amounts of water during cure, a process that is both
14 expensive and energy intensive. To minimize the cost of latex
15 adhesives, substantial quantities of filler material are added.
16 The use of latex filler hinders the effective recycling of
17 manufacturing remnants and used carpet at the end of its life
18 cycle. Alternatively, polyurethane adhesives have been employed
19 to form carpet with superior annealing strength and other
20 desirable physical properties. However, despite the advantages
21 of polyurethane, cost and technical problems have kept it from
22 widespread use in the industry as a coating, and even more
23 rarely as a flexible foam.

1 **[0007]** Attempts to replace latex with polyurethane have
2 resulted in a variety of new problems, requiring modifications
3 to the usual latex annealing process. One striking example is
4 the difficulty associated with placing polyurethane onto a
5 greige material, while maintaining the necessary adhesiveness to
6 attach the second backing. After the pre-polymers have been
7 mixed and polymerization begins polyurethane soon begins to lose
8 its adhesive properties. In addition, because the blow reaction
9 substantially increases the volume of the polyurethane layer,
10 even small irregularities in the application of the polyurethane
11 components to the greige may result in unacceptable variations
12 in the depth of the resulting polyurethane foam layer.

13 **[0008]** Loss of adhesiveness is generally not a problem
14 with the use of latex. Conventional latex maintains its
15 adhesiveness and viscosity during processing, even into the
16 curing oven. Following application of latex adhesive to both
17 the greige and the secondary backing the two components are
18 married and as a result of the latex properties, good temporary
19 adherence of the secondary backing to the greige is observed.
20 In the curing oven, the latex viscosity does not drop
21 significantly as water is evaporated. Thus, the secondary
22 backing satisfactorily adheres to the greige, and little

1 dripping of latex from the bottom of the carpet to the oven is
2 observed.

3 [0009] On the other hand, polyurethane application from
4 bulk troughs, common in latex systems, is made very difficult
5 due to premature polymerization in the delivery line.
6 Typically, polyurethane is applied as "froth," polymerized prior
7 to application and dispensed on the primary or secondary backing
8 before the upstream edge of a doctor blade. However, unless the
9 manufacturer guards against premature polymerization the
10 delivery line becomes clogged, thereby retarding the flow of
11 polyurethane to the dispensing apparatus. In addition
12 polyurethane begins to lose its adhesiveness soon after
13 polymerization begins unless the manufacturer controls the
14 polymerization rate by using heat sensitive catalysts or other
15 chemical agents designed to maintain the viscosity of the
16 polyurethane. Regardless of the manufacturer's attempts at
17 controlling premature polymerization, the manufacturer has only
18 a finite amount of time after the pre-polymers (polyol and
19 isocyanate) have been mixed in which to apply the polyurethane
20 and contact the greige to the backing before the polymer begins
21 to lose its adhesive properties.

22 [0010] In an attempt to combat the rapid loss of
23 adhesiveness manufacturers have applied one coating of

1 polyurethane to the greige as fiber lock and a second coating of
2 polyurethane just prior to contacting the secondary backing to
3 insure sufficient adhesion between the backings. Even with the
4 additional polyurethane, the slow advancement of most commercial
5 carpet lines, and the inherent lack of adhesiveness associated
6 with polyurethane, does not allow for the desired adherence
7 between the greige and the secondary backing.

8 [0011] Curing the backing to the greige is also
9 complicated because of the considerable decrease in viscosity of
10 the polyurethane prior to cure. The viscosity of the
11 polyurethane, and likewise its adhesiveness, may decrease to
12 only 10% of its initial value prior to application of the
13 secondary backing as the catalyzed polyurethane-forming reaction
14 begins to exert its effect. The greatest decrease in viscosity
15 is often exhibited over the temperature range of ambient to 70°
16 C., where the polyurethane catalysts are not optimally active.
17 As a result, if the initial adherence of the secondary backing
18 to the greige is insufficient the secondary backing may separate
19 during this period of low viscosity.

20 [0012] In an attempt to address the problems associated
21 with the use of polyurethane several changes to the underlying
22 process have been disclosed. For example, U.S. Pat. No.

1 6,264,775 offers the addition of various chemical thickening
2 agents to the polyurethane to maintain viscosity and
3 adhesiveness. Another process provides for the use of multiple
4 applications of polyurethane to the primary backing prior to
5 joining the secondary backing. See e.g., U.S. Pat. No.
6 6,299,715. Still another technique disclosed in U.S. Pat.
7 No.6,299,715, is the application of both polyurethane to the
8 primary backing and another tacky composition to the secondary
9 backing prior to joining the two backings. In U.S. Pat. No.
10 4,515,646, two of the present inventors even tried to use
11 refrigerated isocyanate and polyol components without catalysts
12 to prevent premature polymerization. None of these techniques
13 have been favored over standard latex based carpet laminates,
14 primarily due to the increased cost and complexity associated
15 with building and using separate manufacturing lines to
16 implement the new technologies, or the failure of the techniques
17 to work in a production environment.

18 [0013] It would therefore be desirable to provide a
19 polyurethane foam carpet annealing process requiring only a
20 single application of the polyurethane, while providing
21 acceptable fiber lock and annealing strength. It would also be
22 desirable to provide a polyurethane annealing system which does
23 not require excessive quantities of polyurethane to provide

1 sufficient annealing strength. It would be beneficial to
2 provide a polyurethane annealing system which does not require
3 an oven for curing.

4 5 SUMMARY OF INVENTION

6 [0014] The present invention pertains to a polyurethane
7 carpet annealing system which discloses several unique
8 advantages over the prior art. First it requires only a single
9 application of polyurethane. The lower amount of polyurethane
10 employed in a single application significantly decreases the
11 weight of the carpet and decreases raw material costs. Second,
12 the polyurethane is blown and cured at ambient temperature. The
13 absence of an oven-curing step markedly decreases the time from
14 application of the polyurethane to product roll-up. Third, the
15 principal source of water for the blow reaction is from steam
16 applied to the polyurethane ingredients after they have been
17 dispersed upon the greige. Fourth, a vacuum or ultra sonic
18 system may be employed prior to application of steam to increase
19 the penetration of the polyurethane ingredients into the greige.
20 The carpet produced by the process exhibits acceptable fiber
21 lock and initial secondary backing adhesion without the use of
22 large quantities of polyurethane and without the expensive heat
23 curing step common in other annealing systems. In combination,

1 the two advantages significantly increase the commercial utility
2 of the product.

3
4 **BRIEF DESCRIPTION OF DRAWINGS**

5 [0015] Figure 1 illustrates a typical prior art latex-
6 based carpet annealing process.

7 [0016] Figure 2 illustrates a preferred dispensing
8 apparatus for applying mixed polyurethane components to a film.

9 [0017] Figures 3a and 3b illustrate front and side views
10 of a preferred construction of the dies used to dispense the
11 polyurethane components onto the film.

12 [0018] Figure 4 is an alternatively preferred dispensing
13 apparatus for mixing and dispensing the polyurethane components
14 onto the film.

15 [0019] Figure 5 illustrates one embodiment of the
16 present invention.

17 [0020] Figure 6 illustrates a second embodiment of the
18 present invention.

19 [0021] Figure 7 illustrates a third embodiment of the
20 present invention.

21 [0022] Figure 8 illustrates a fourth embodiment of the
22 present invention.

1 [0023] Figure 9 illustrates a fifth embodiment of the
2 present invention.

3 DETAILED DESCRIPTION OF THE INVENTION

4 [0024] The present invention is designed to improve the
5 annealing of secondary backing to tufted or woven carpeting
6 utilizing a polyurethane adhesive system. Referring now to the
7 drawings in more detail, Figure 1 illustrates a typical prior
8 art commercial latex-based carpet annealing process. The greige
9 5, with top carpet face 10 and bottom primary backing side 15 to
10 which fiber lock adhesive is applied, is directed by rollers 20
11 to place the primary backing side 15 of the greige under trough
12 25, which is supplied with latex through line 30. The downstream
13 edge of trough 25 serves as a doctor blade 35, in conjunction
14 with plate 40. Adjusting the amount of latex applied also
15 serves to force the latex through the primary backing 15 into
16 the fibers. Further penetration is provided by pressure roller
17 45. The carpet is then redirected by roller 50. Secondary
18 backing 55 is supplied from roll 60 and directed by rollers 65
19 across wheel-roll 70, which rotates in trough 75 filled with
20 additional latex which coats the secondary backing 55. The
21 coated secondary backing 77 is pressed onto the latex-coated
22 greige 80 by their travel through ligation rolls 85. The carpet
23 then passes through oven 90 where water is removed from the

1 latex, and the latex cures, adhering fibers and secondary
2 backing to form a lamellar carpet.

3 [0025] It will be understood that in most prior art
4 polyurethane backings, water is not added to the froth and the
5 resulting polyurethane backing is not "blown," the only volume
6 in the backing layer having been injected in the form of air in
7 the froth. The present invention is directed to a flexible
8 polyurethane foam that is blown, rather than merely a
9 polyurethane coating.

10 [0026] Figure 2 illustrates a preferred dispensing
11 apparatus for mixed polyurethane onto the greige. The greige
12 11, is fed in direction 12 past the dispensing apparatus 10.
13 The dispensing apparatus 10 preferably comprises a polyol tank
14 21, iso tank 22, and catalyst tank 23. Polyol tank 21 contains
15 polyol mixed with filler and surfactants, such as silicone. The
16 iso tank 22 contains isocyanate. The catalyst tank 23 contains
17 one or more catalysts and a small amount of water. Typically,
18 there will be between fifty and one hundred parts filler per
19 hundred parts of polyol and between about 0.05 to 3.0 parts of
20 water per hundred parts of polyol. Contents of polyol tank 21
21 are pumped by pump 24 through tube 28 to mix head 27. The
22 temperature of the polyol mixture maybe controlled either by
23 refrigerating the entire polyol tank 21 or by passing tube 28

1 through a heat exchanger to achieve the desired temperature
2 prior to mixing. Similarly, the contents of iso tank 22 are
3 pumped by iso pump 25 through tube 28 to mix head 27 and
4 contents of catalyst tank 23 are pumped by pump 26 through
5 another tube 28 to mix head 27. There may be an additional
6 input line to mix head 27 for air or inert gas in order to
7 increase the frothing of the mixture in mix head 27. All of the
8 ingredients may be temperature controlled as described in
9 connecting with the polyol mixture above. In addition. there
10 may be other additives such as stabilizers, antioxidants,
11 antimicrobials, anti-mildew agents, colorants, flame retardants,
12 and chain extenders, all depending upon the characteristics
13 desired in the resulting foam. The illustrated mix head 27
14 dispenses polyurethane mixture through outlet tubing 29 to a
15 plurality of die heads 30 extending across a substantial width
16 of the greige 11. In this embodiment, is anticipated that each
17 individual die head 30 will be between about four and twelve
18 inches in width, and preferably between about six to nine inches
19 in width.

20 [0027] The pumps 24, 25, 26 precisely meter the
21 constituent components of the polyurethane. Mix head 27 not
22 only mixes and froths the components but also evenly controls
23 the distribution of the polyurethane mixture to each of the die

heads 30. After the mixture and frothing of the polyurethane components, outlet tubes 29 from the mix head 27 may also pass through heat exchanger apparatus to alter the viscosity and reaction time of the polyurethane.

[0028] Back pressure helps keep the distribution from the material exiting the die heads 30 consistent and even across the width of the greige 11. The die head lips 33 shown in figure 3 may be adjusted depending upon the amount of polyurethane material to be applied. At least one of the die lips 33 can be permitted to touch the back of the greige 11, or both lips 33 may be raised to avoid contact with greige 11.

[0029] The adhesion of the polyurethane material to the greige 11 may be accomplished by the use of a roller, a doctor blade, controlled vacuum, ultrasonic waves or an air knife, and in some instances, by the viscosity of the polyurethane material. Penetration into the greige is critical to achieving acceptable tuft bond and annealing strength.

[0030] Figure 4 illustrates an alternative embodiment for applying mixed polyurethane components to greige 11. In this instance, tanks 21, 22, 23, are associated with pumps 24, 25, 26 to convey the polyurethane components through inlet tubes 28 to a plurality of a small mix heads 27 that are substantially directly connected to die heads 30. This structure permits the

polyurethane components to be blended and dispersed without passing through mix head outlet tubes 29, such as illustrated in figure 2. By placing the mix head 27 closer to the actual application of the polyurethane components, there is less time for a reaction to occur before the components are on the greige 11, thereby reducing the chance of clogging the dispensing apparatus. The modules of figures 2 and 4 may be repeated across a wider film than illustrated, typically, up to approximately four or five meters in total width.

[0031] Figure 5 illustrates the carpet manufacturing process according to the present invention. The greige 5 with carpet face 10 downward is fed onto a tenter roll 12 that directs the greige 5 to metering plate 95, the carpet face 10 is advanced over the metering plate 95 using pulling rollers 21.

[0032] In Figure 5, a layer 100 of polyurethane polymer is deposited onto the primary backing side 15 as it passes over metering plate 95 using a mixing head 105. Preferably, the polyurethane is applied to the primary backing 15 at an area concentration of about 6 to 40 ounces per square yard or in a more preferred concentration of about 12 ounces per square yard.

[0033] In an even more preferred embodiment of the present invention, the polyol and isocyanate pre-polymer components are mechanically blown with catalyst, filler and

1 other additives through a mixing head 105 to form the
2 polyurethane layer 100. This prevents the pre-polymers from
3 contact until just prior to application to the primary backing
4 15. At this time, only a small amount of water is added which
5 reacts and serves as a blowing agent. According to this method,
6 the polymerization process does not begin to occur until just
7 prior to the exit of the polyurethane components from the mixing
8 head 105. This process allows the relatively low viscosity
9 polyurethane to deeply penetrate the fibers in the primary
10 backing, resulting in excellent fiber lock characteristics.

11 [0034] After the polyurethane components are applied
12 polymerization and foaming begins but at this time most of the
13 volume of the polyurethane mixture is a result of frothing in
14 the mix head. The thickness of the polyurethane foam may be
15 adjusted by various means known in the art such as a doctor
16 blade 35 or air knife. This is generally unnecessary, however,
17 as the die heads 30 provide for a very even and controlled
18 dispersal of polyurethane on the greige. The polyurethane
19 coated greige 79 is then optionally passed across a steam box
20 150, that is adjustable with respect to steam temperature,
21 volume, and slot size. Steam box 150 adds more water to
22 facilitate the blow reaction and heat to aid in accelerating the
23 gel reaction. In addition the steam serves to enhance blooming

1 of the yarns passing through the primary backing for deeper
2 penetration and assures a more level coverage of polyurethane.
3 A fume hood 155 is placed above the steam box 150 to capture
4 escaping volatiles released with the steam. Conspicuously
5 absent at this stage of the process is an oven curing step. An
6 oven is not necessary in the process because the polyurethane
7 components are essentially kept separate until they are applied
8 to the primary backing 15, therefore there is no need to dope
9 the polyurethane components in order to control the rate of
10 polymerization.

11 [0035] In a preferred embodiment of the present process
12 temperatures are generally maintained within 30° F of ambient
13 temperature or in a more preferred embodiment within 15° F of
14 ambient temperature during the carpet manufacturing process. In
15 contrast, prior art polyurethane curing processes are required
16 to utilize heat sensitive catalysts and other chemical additives
17 to maintain sufficient viscosities to apply the polyurethane,
18 from various holding lines and troughs, to the backing surface.
19 These additives, and the absence of water, necessitate a heat
20 curing stage.

21 [0036] After applying the polyurethane coating, and
22 steaming the coated greige 79, the coated greige 79 is rapidly
23 pulled to merge roll 160 where the secondary backing 55,

1 supplied from roll 60, contacts the coated greige 79 downstream
2 from roller 87. Due to the short time that elapses between the
3 initial application of polyurethane and the merger of the
4 secondary backing 55 with the coated greige 79, the polyurethane
5 possesses sufficient tackiness to anneal the secondary backing
6 in place.

7 [0037] The merge roll 160 not only contacts the
8 secondary backing 55 to the coated greige, but also serves to
9 gauge the height of the blown polyurethane, preferably at no
10 more than about one-eighth inch in height, and to halt any
11 additional volumization of the polyurethane. This is due to the
12 merge roll 160 compressing the blown polyurethane and rupturing
13 many of the still closed cells within the polyurethane. In a
14 preferred embodiment, the secondary backing is a spun bonded
15 fabric of nylon, polypropylene, polyester, polyethylene or
16 similar fibers and may have a calendared surface.

17 [0038] The independence gained by controlling the mixing
18 of polyol and isocyanate has lead to the removal of a curing
19 station. The excision of this step has dramatically improved
20 the processing speed of laminated carpets, cutting manufacturing
21 time by as much as 50-60% without sacrificing the annealing
22 strength or fiber lock properties of the carpet. The annealed

1 carpet can then be cooled briefly 190 and rolled for storage and
2 transport.

3 [0039] Figure 6 illustrates an alternative carpet
4 manufacturing process according to the present invention. The
5 greige 5 with carpet face 10 downward is fed to metering plate
6 95. Polyurethane is sprayed from mixing head 105 onto the
7 primary backing side 15. A doctor blade 35 or air knife insures
8 that the sprayed polyurethane is not excessively puddled and the
9 resulting primary backing has a relatively even layer of
10 polyurethane 100. The carpet may at this point be fed over a
11 vacuum 152 or ultra sonic wave device in order to pull the
12 viscous polyurethane deeper into the primary carpet backing.
13 Then the carpet continues across steam box 150 and fume hood 155
14 which adds water to the blow reaction. The heat from the steam
15 box also accelerates polymerization and provides the additional
16 benefit of enhancing blooming of the face yarns on the carpet.
17 Again, oven curing is not necessary. Then a backing roll 60
18 feeds secondary backing 55 downward to merge roller 160 where
19 the secondary backing is applied to the still curing and tacky
20 polyurethane film layer 100. In the event the polyurethane film
21 has cured sufficiently to lose much of its tackiness, the
22 secondary backing 55 may require coating to enhance its
23 adherence to the product. As in Figure 5, the polyurethane

1 polymer layer **100** is preferably applied to the primary backing
2 **15** at an area concentration of about 6 to 40 ounces per square
3 yard or in a more preferred concentration of about 12 ounces per
4 square yard. In an even more preferred embodiment of the
5 invention, the polyol and the isocyanate prepolymer components
6 are mechanically blown through the mixing head **105** with water
7 and other additives in a fashion that prevents the prepolymers
8 from contact until immediately prior to application of the
9 primary backing. In addition, in order to further retard the
10 polymerization process until the polyurethane components reach
11 the primary backing, refrigeration of the prepolymers may be
12 employed.

13 **[0040]** The action of the merge roller **160** after the
14 secondary backing is applied tends to crush the now polyurethane
15 foam layer **100**. Crushing, by rupturing many of the still closed
16 cells within the film effectively stops the expansion of the
17 film backing and permits curing to continue without
18 substantially increasing the volume of the polyurethane layer
19 **100**. The film backed carpet is then fed through accumulator
20 rolls **120** as curing is completed and is finally wound on a take-
21 up roll in a finished state, typically in lengths of up to about
22 600 feet.

1 **[0041]** Figure 7 is an illustration substantially of the
2 polyurethane film backing line of Figure 6, however in this
3 configuration, the secondary backing **55** is applied at a much
4 earlier stage in the process. In fact, immediately after the
5 polyurethane polymer layer **100** is deposited on the backing side
6 **15** of the greige as it passes over metering blade **95**, the
7 secondary backing **55** is applied, preferably by transition around
8 a doctor bar **35** which causes the secondary backing **55** to come
9 into contact with the polyurethane polymer layer **100** as the
10 reaction of the prepolymers and water is just beginning.
11 Advancing the secondary backing **55** around the doctor bar **35**
12 provides the additional benefit of keeping the doctor bar **35**
13 clear from any accumulations of polyurethane. The polyurethane
14 polymer layer **100** begins its reaction between the primary
15 backing side **15** and the secondary backing **55** and the use of
16 steam box **150** and fume hood **155** accelerates this process and
17 provides additional water to the reaction. Again passing under
18 merge roller **160** crushes the backing and effectively halts the
19 foaming process so that the polyurethane layer does not gain
20 additional height. The curing process is completed as the
21 carpet passes through accumulator **120** and is finally wound on a
22 master carpet roll.

1 **[0042]** Figure 8 illustrates another variation of the
2 present invention in which the polyol and catalyst is mixed and
3 applied in a puddle or froth onto the primary backing side 15 of
4 the greige 5 over metering plate 95. Doctor bar 35 or air knife
5 or other suitable means are utilized to insure even and
6 controlled amounts of polyol, water and catalyst. As the greige
7 proceeds through the line, one or more spray heads 105 dispense
8 the isocyanate prepolymer component onto the prepolymer layer of
9 polyol and catalyst. This permits the initiation of the
10 polymerization process and the use of steam box 150 and fume
11 hood 155 provides additional water to optimize blowing and
12 foaming and accelerates the polymerization process. Secondary
13 backing 55 is then applied and merging roll 160 crushes the film
14 layer of both ensuring a complete adherence of the secondary
15 backing to the polyurethane layer and stopping increased
16 volumization of the polyurethane film layer. The backed carpet
17 then passes through accumulator 120 to complete its curing and
18 is then wound on to a master roll. It will be understood that a
19 vacuum may be added to the configuration of Figure 8 either
20 after the metering plate 95 or after the spray head 105 to help
21 insure that the polyurethane polymer is drawn sufficiently into
22 the primary backing.

1 **[0043]** Yet another variation of the present invention
2 involves passing the primary backing side 15 of the greige
3 5 over a foam pan 111 containing polyol, water and catalysts,
4 the mixture being denominated 112 in Figure 9. Wetting roller
5 113 carries a film of polyol, water and catalysts mixture 112 to
6 the primary backing side 15 of greige 5 and doctor bar 35
7 facilitates even application. Once the primary backing side 15
8 is again upward facing, spray head 105 dispenses isocyanate so
9 that polymerization may begin. Passing the layer of
10 polyurethane polymer over steam box 150 and fume hood 155
11 provides more water for the reaction and heat to acceleration
12 the polymerization. Again the secondary vacuum 55 is applied
13 and merge roller 160 crushes the foam back ensuring contact
14 between the secondary backing and the polyurethane polymer layer
15 and halting the increased volumization of the foam layer. The
16 carpet completes its curing as it passes through accumulator 120
17 and wound onto the master roll.

18 **[0044]** In all of the foregoing embodiments, the Figures
19 have been simplified for clarity and to ease viewing and
20 understanding. In commercial embodiments, additional devices,
21 e.g. drive motors, tension devices, etc. will be required.

22 **[0045]** Polyurethane prepolymers useful in the practice
23 of the present invention are prepared by the reaction of active

1 hydrogen compounds with any amount of isocyanate in a
2 stoichiometric excess relative to active hydrogen material.

3 [0046] The prepolymer formulations of the present
4 invention include a polyol component. Active hydrogen
5 containing compounds most commonly used in polyurethane
6 production are those compounds having at least two hydroxyl
7 groups or amine groups. However, any active hydrogen containing
8 compound can be used with the present invention, and indeed some
9 soy based oils can be used.

10 [0047] In the practice of the present invention,
11 preferably at least 50 weight percent of the active hydrogen
12 compounds used to prepare the polyurethane is a polyol having
13 molecular weight of from about 100 - 400.

14 [0048] The polyisocyanate component of the formulations
15 of the present invention can be prepared using any organic
16 polyisocyanates, modified polyisocyanates, isocyanate based
17 prepolymers and mixtures thereof. These can include aliphatic
18 or aromatic isocyanates. Preferably the isocyanate used to
19 prepare the prepolymer formulation of the present invention is
20 methyl diisocyanates such as Bayer's 142L or Dow p901 or blends
21 of equal type.

22 [0049] Catalysts suitable for use in preparing the
23 polyurethane of the present invention include tertiary amines,

1 and organometallic compounds and mixtures thereof. For example,
2 suitable catalysts include stannous octoate, triethylenediamine,
3 N-methyl morpholine, like compounds and mixtures thereof. The
4 catalysts do not necessarily need elevated activation
5 temperatures or other promoters to initiate polymerization.

6 [0050] Surfactants can be useful for preparing a stable
7 dispersion of the present invention. Surfactants useful for
8 preparing a stable dispersion can be cationic, anionic, or non-
9 ionic surfactants. Preferably the surfactants used to prepare
10 the prepolymer formulation of the present invention are silicone
11 surfactants such as Dow Corning DC-194 or Union Carbide's L-540.
12 A surfactant can be included in a formulation of the present
13 invention in an amount ranging from about 0.01 to about 7 parts
14 per 100 parts by weight of polyurethane component.

15 [0051] A compound of the present invention optionally
16 includes a filler material. The filler material can include
17 conventional fillers such as milled glass, calcium carbonate,
18 aluminum trihydrate, barium sulfate, fly ash, dyes and pigments
19 or fire retardants (aluminum trihydrate and Tris polyolefin
20 glycol). Preferably the filler can be present in an amount
21 ranging from 0 to 300 parts, and more preferably between 100 and
22 250 parts, per 100 parts of the polyurethane component.

1 **[0052]** Generally, any method known to one skilled in the
2 art of preparing polyurethane froths can be used in the practice
3 of the present invention to prepare a polyurethane froth
4 suitable for preparing a carpet of the present invention,
5 however, typically only one of the prepolymer mixtures is
6 frothed, since the use of water as a blowing agent provides
7 ample volume to the polyurethane. It is also possible to froth
8 the polyurethane mixture in the mix head by adding air or inert
9 gas at that point.

10 **[0053]** Although a preferred embodiment of the present
11 invention has been disclosed herein, it will be understood that
12 various substitutions and modifications may be made to the
13 disclosed embodiment described herein without departing from the
14 scope and spirit of the present invention as recited in the
15 appended claims.